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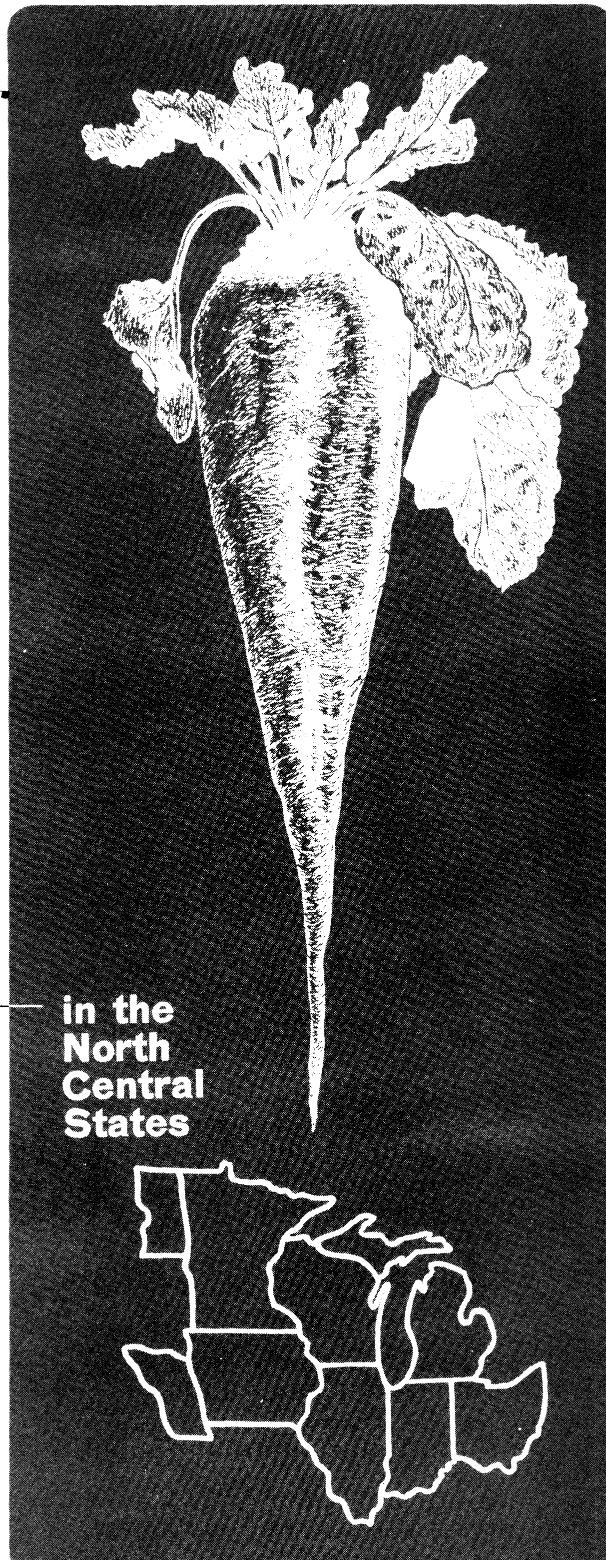
Farmers' Bulletin No. 2060

SUGARBEET CULTURE

in the North Central States



U. S. DEPARTMENT OF AGRICULTURE

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Some of the photographs were obtained from the Farmers & Manufacturers Beet Sugar Association and from the E. E. Patton collection through the courtesy of Mrs. Emily Patton Colmus.

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SUGARBEET CULTURE IN THE NORTH CENTRAL STATES

By J. G. LILL,[1] formerly *agronomist,*
Crops Research Division, Agricultural Research Service

Sucrose, the sugar of commerce and kitchen, is extracted from the tissues of the sugarbeet and the sugarcane. Whichever plant it comes from, the product, when pure, is identical in all properties and for all purposes.

The sugarbeet is a biennial plant that is cultivated for the sugar it stores in the root. In comparison with other plants, the quantity stored is high, frequently reaching 20 percent of the root weight. The sugar is formed in the leaves from water and carbon dioxide in the presence of chlorophyll (the green coloring matter of the leaves), sunlight supplying the energy for this chemical process. The greater part of the sugar made by the leaves may be used by the plant during its period of rapid growth, but when vegetative growth is slowed in late season a large part of the sugar is stored and the roots become of high quality. The commercial crop is harvested at or near the end of the period of the first year's growth when the roots have reached a relatively large size and contain the maximum amount of sugar.

Sugarbeet-Producing Areas in the United States

In the United States, sugarbeets are successfully grown in four fairly distinct areas that differ from each other by climatic or cultural conditions: (1) The humid area located in the North Central States; (2) the Great Plains area; (3) the Mountain States area; and (4) the Pacific coast area.

In the humid area where the crop is grown almost entirely under natural precipitation, sugarbeet-growing districts have been developed in Michigan, Ohio, Indiana, Wisconsin, Minnesota, Iowa, Illinois, eastern North Dakota, and eastern Nebraska. The production of sugarbeets is not general over this whole area but is restricted to districts where soil and other conditions are favorable. Of the average annual harvested acreage for the United States, approximately one-fourth has been in the humid area.

Unlike other important field crops, the sugarbeet crop is always grown under contract with a beet-sugar factory (fig. 1), since sufficient acreage must be planted to beets to produce the tonnage necessary for factory operation. Acceptance of the contracts by the company is delayed until such acreage has been signed up. Thus the sugarbeet contracts, entered into yearly by the growers, carry stipulations as to the acreage to be grown, the seed to be used, planting, cul-

[1] Retired 1953.

ture, harvest, and crop delivery. The factory supplies the seed at a stipulated price and will accept the crop grown if it meets certain minimum conditions or quality requirements when delivered. In the humid area it has seldom, if ever, been necessary to refuse beets on account of low quality.

The contracts under which the beet crop is grown in some districts of the humid area are of the participating type under which the proceeds from the sale of sugar, pulp, and molasses are divided between the processor and the growers upon some percentage basis, as, for example, 50–50. The growers' portion of the returns is subdivided among the individual growers according to the tonnage each has delivered. Under such contracts, the grower's obligation is to produce the beets and deliver them to the factory, and the factory's obligation is to process the beets and market the sugar, pulp, and molasses.

Climatic Adaptation

For successful production in the humid area, the sugarbeet crop requires plentiful and well-distributed moisture during the growing season. The quantity of water required for continuous growth bears a very definite relationship to the amount of foliage that has developed, more and more being required as the foliage increases in size. As the season becomes warmer the demand for water also increases. In the humid area nearly half of the total annual precipitation normally occurs during the growing season, May to September, inclusive.

FIGURE 1.—Beet-sugar factory, showing storage piles with pile-ventilating equipment installed in some piles.

Although the precipitation during the early part of the growing season is probably more than is actually required by the crop, the quantity received during August and September is not likely to exceed what the crop can use. During the latter part of the growing season when the precipitation received may not be sufficient to meet the demands of the foliage and when the crop has drawn heavily upon the moisture reserves in the soil, there is usually a decrease in the amount of foliage present. Some farmers supplement rainfall by irrigation (fig. 2).

In addition to the adequate supply of moisture, the sugarbeet crop is favored by a long and moderately cool growing season. Nearly all of the beet-sugar factories operating in the humid area are located in areas with a mean summer temperature (May to September, inclusive) of 67° to 72° F., as shown in figure 3. Although it is possible to grow the sugarbeet outside this zone in the humid area, its culture has not proved promising. Warm days and fairly cool nights during the growing season combine to favor the rapid growth of the crop. In the latter part of the season, progressively cooler nights, the exhaustion of available nitrogen, and the decreasing moisture supply slow up vegetative growth and accelerate sugar storage.

Soil Requirements

In the humid area, sugarbeets are grown upon both the mineral soils, derived from decomposed rock, and the organic-type, or muck, soils. Although the greater part of the sugarbeet acreage is upon mineral-type soils, muck soils are sometimes used for sugarbeet production. While these soil types differ radically in their physical properties, both should have good depth, adequate drainage, be well aerated, and should not be strongly acid. In addition to these qualities,

FIGURE 2.—Irrigation of sugarbeets in the humid area by means of a sprinkler system.

the mineral soil types should also have high organic content and high moisture-holding capacity.

Experience with the mineral soil types has shown that those that combine the necessary characteristics to make them adaptable for successful sugarbeet production are usually the dark-colored, heavier types, such as loams, silt loams, clay loams, and clays as represented by the Toledo-Vergennes (Brookston-Toledo), the Miami-Kewaunee (Conover), and the Miami-Crosby-Brookston soil-type associations, although satisfactory yields have often been obtained upon lighter textured mineral soils.

The organic soils, or mucks, are characterized by their extremely high organic content and moisture-holding capacity. Many of these soils are not suitable for growing sugarbeets, whereas others give very satisfactory root yields, although the quality of the crop may not be high as that obtained with the mineral soil types.

Normally the sugarbeet sends its taproot deep into the soil (fig. 4), and soil structure or other conditions that limit depth of root penetration decrease the volume of soil upon which the taproot and its numerous small feeding roots may draw for the mineral elements and moisture used in growth. Practically all soils upon which high yields are regularly produced have a depth of at least 3 feet before there is any change in the physical characteristics that prevent the penetration of roots. On the other hand, if the depth of root penetration is limited by repellent soil structures, by a high water table, or by poor soil aeration, the roots harvested are apt to be short and ill-shaped (fig. 6). If the soil has sufficient depth, the roots harvested will be long and tapering (fig. 5). Although it is sometimes possible to obtain a fair tonnage from a field where soil structures or drainage conditions prevent beets from making their normal growth of well-

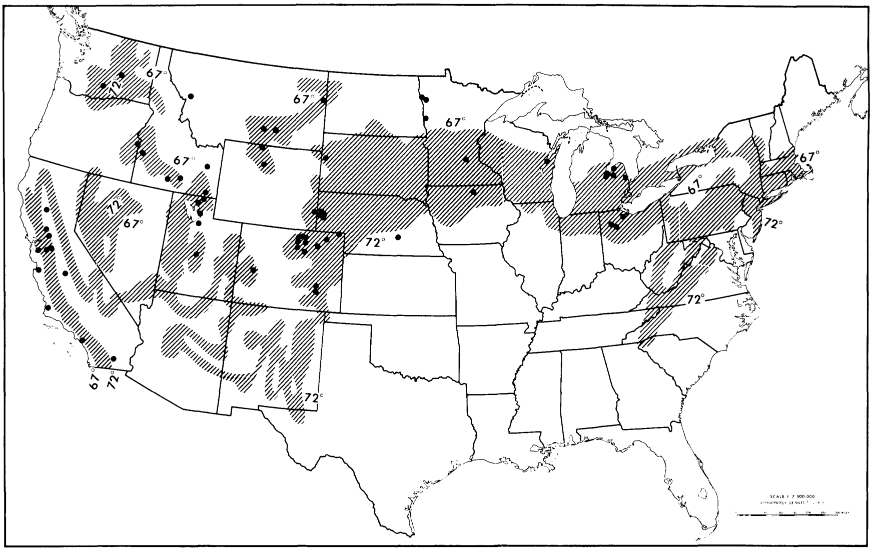

FIGURE 3.—Beet-sugar factories in the United States. The shaded portion shows the zone having a mean summer temperature of 67° to 72° F.

formed roots, tare and tailings loss at the factory is increased with such roots.

In the humid area far greater loss is brought about by lack of adequate surface and tile drainage than is commonly supposed. Provision must be made to permit the water resulting from heavy rains to be carried off from the beetfields into drainage ditches or catch basins with a minimum of opportunity for soil erosion. The accumulation of surface water when no escape channels are provided often results in serious crop damage. Lack of tile drainage (fig. 7) permits the water that has penetrated the soil to remain there, limiting the aeration of the soil and the depth to which the

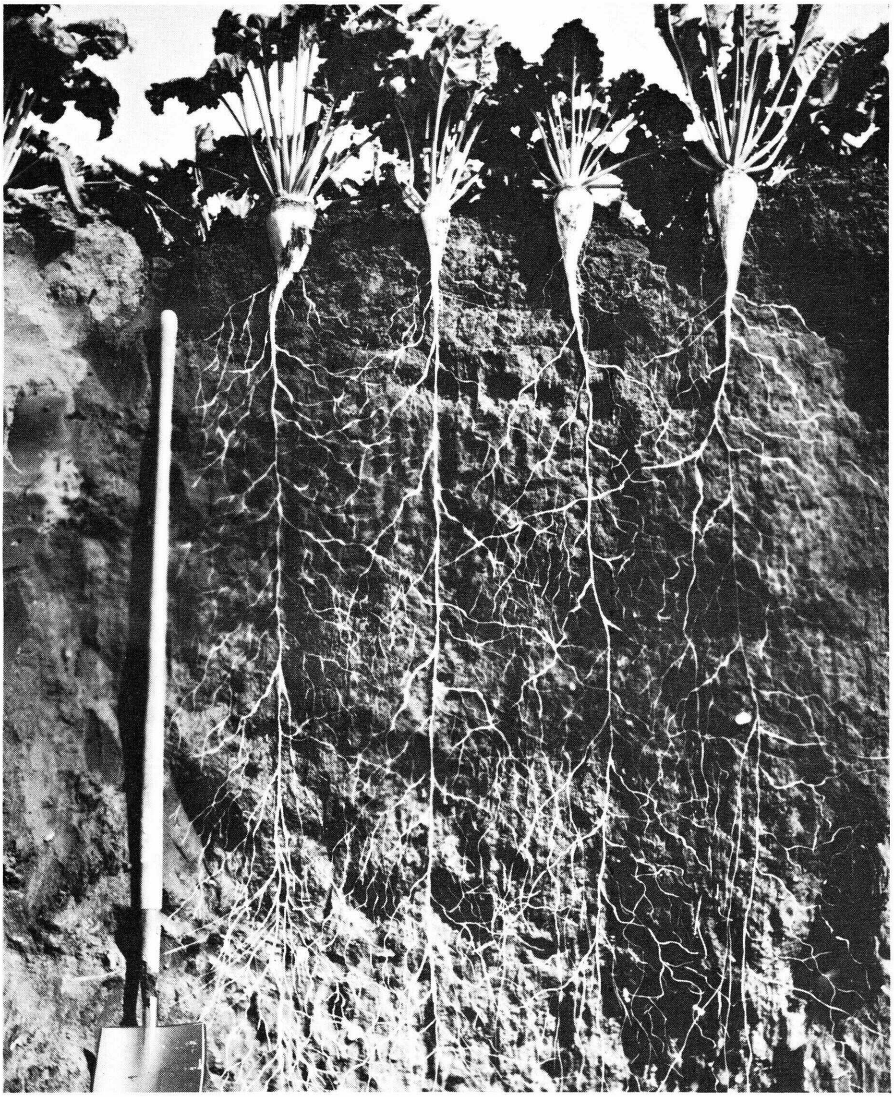

FIGURE 4.—The sugarbeet sends its taproot deep into the soil.

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FIGURE 5.—A sugarbeet of desirable shape.

beet roots can penetrate, and thus limiting the volume of soil upon which the crop can draw for its mineral and moisture supply.

The sugarbeet is productive on either slightly acid or alkaline soils in the humid area, the crop being grown upon soils testing as low as pH 5.8 to 6.0 (acid) and as high as pH 7.5 or more (alkaline). For the best results it is generally considered that the soil should be only slightly acid to neutral in reaction. If good stands of alfalfa and clover can be obtained upon a field, the reaction is favorable for the sugarbeet crop.

Although the beet crop can withstand drought as well as or better than most other cultivated crops, if the amount of moisture held within the soil is insufficient during a drought period so that growth lags, then the yield is correspondingly reduced. It is during these periods that the heavier types of mineral soils and the organic soils, with their higher moisture-holding capacities, have a great advantage over the lighter soil types (fig. 8). Sandy

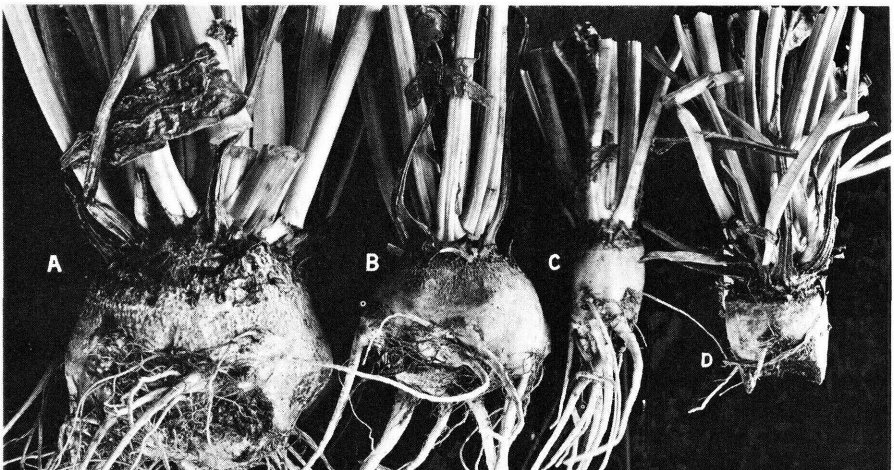

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FIGURE 6.—Sugarbeets of undesirable shape, caused by a high water table.

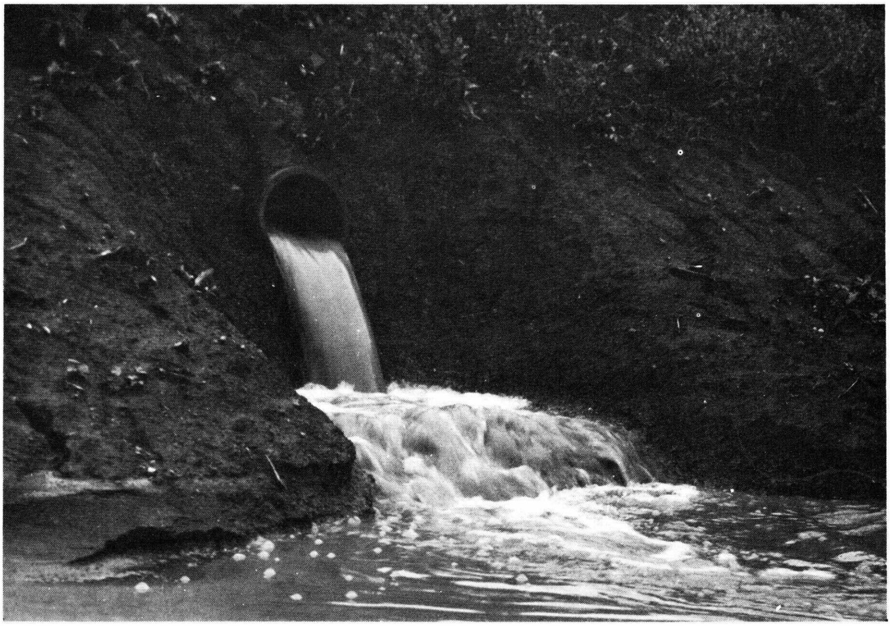

FIGURE 7.—Adequate tile drainage permits the excess water in the soil to escape.

FIGURE 8.—Contrasting growth of sugarbeets on darker and heavier mineral soil (*foreground*) and on lighter mineral soil (*center and background*).

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areas in a field, as well as areas with a sandy subsoil, are often clearly outlined during the heat of the day by the wilting of all the beet foliage within such areas, whereas the foilage of the plants on the adjacent darker and heavier soil shows no lack of moisture.

Rotations

In the production of the sugarbeet crop in the humid area, the rotations followed are quite different for the mineral-type and the organic-type soils.

For the mineral-type soils, a properly designed rotation (1) provides for the addition of nitrogen either from soil-building crops or as manure or fertilizer used with cash crops; (2) maintains humus and rebuilds the tilth of the soil; (3) permits more effective use of labor in land preparation, especially through the economical utilization of the condition of the soil as left by the preceding crop; (4) decreases the cost of production by reducing demands for labor; (5) gives ample opportunity to attain and maintain an essentially weed-free condition; and (6) allows the beet crop to avoid, to a very considerable extent, insect pests and plant diseases that may attack the crop. For the organic soils, the principal advantages of crop rotation are (1) the elimination or avoidance of plant diseases; (2) the most effective utilization of the phosphorus and potassium fertilizers that have been applied to such soil; and (3) the control of weeds.

For a mineral soil, the properly planned rotation for sugarbeets will include one or more legumes, sod, or mixed legume-and-sod crops that will add organic matter to the soil. If leguminous crops are used alone or are included in a mixture, the double purpose of adding organic matter and nitrogen to the soil is accomplished. Of the soil-building legumes, alfalfa, sweetclover, and the clovers, when plowed under, are most effective. Bromegrass is becoming very popular for use in legume-grass mixtures, as the fine fibrous roots of the grass have a very beneficial effect upon the tilth of the soil in bringing about a desirable crumbly soil structure.

On the mineral soils in the humid area the sugarbeet crop should be grown as the first or second crop in the rotation following the turning under of the green-manure crop. Although higher yields are quite commonly obtained when the sugarbeets are grown immediately following the green-manure crop, not all growers follow this practice, many of them preferring to plant sugarbeets as the second crop following the soil-building crop. If sugarbeets are grown immediately following the turning under of the green-manure crop the maximum benefit may not be obtained, since the organic matter turned under may not have had time in which to decay. The decay of organic matter may be hastened by applying chemical nitrogen to the green-manure crop just before it is turned under. The use of an intertilled crop between the green-manure crop and the sugarbeets in the rotation gives ample time for the decomposition of the organic matter to improve the tilth of the soil and makes possible effective control of any weeds that may have obtained a foothold during the year or years in which the field was in the soil-building crop.

The occurrence of seedling diseases (black root or damping-off) seems definitely to be increased if the sugarbeets are planted shortly after the spring plowing of alfalfa, sweetclover, or red clover crops. Loss from such diseases is reduced

if corn, beans, soybeans, or possibly some other cultivated crop is grown following the green-manure crop and preceding sugarbeets in the rotation. The adverse effects on stand that come from growing the sugarbeet crop as the first crop following the turning under of alfalfa or other leguminous crop in the spring can be avoided by turning under the legume crop in late August or early September of the previous year. High yields are being obtained on the mineral soils by the growers who have adopted this practice.

Mineral soils on which alfalfa and clovers have occupied a field for 3 or more years may be found to be infested with cutworms and white grubs, and in the lower, wetter places with wireworms. Late summer or early fall plowing will reduce the injury by such pests to the following sugarbeet crop. If early fall plowing cannot be done, an intervening cultivated crop less subject to insect injury may be grown. Two intervening cultivated crops may be necessary to eliminate injury from wireworms if the soil is heavily infested.

The sequence of crops within a properly planned rotation for either mineral or organic soils should be such as to leave the soil, prior to the planting of the beet crop, as free from weeds as possible. Successful mechanization of the spring work depends on elimination of weeds.

A well-planned rotation gives ample time between the removal of one crop and the planting of the next for proper preparation of the soil. It has been demonstrated repeatedly that higher yields of sugarbeets are obtained from fall-plowed mineral soils as compared with the yields obtained from such soils when spring plowed (fig. 9). A cropping system that allows the removal of the preceding crop early enough to permit early fall plowing of the mineral soils for the next year's sugarbeet crop is strongly recommended for the humid area.

On organic soils, or mucks, the properly planned rotation for sugarbeets will include such crops as are not subject to the same diseases or attacks by the same insects as the sugarbeets. Such rotations should also permit ample opportunity for weed elimination.

FIGURE 9.—Effect of the date of plowing of mineral soil upon the growth of sugarbeets: (*Left*) beets on fall-plowed soil; (*right*) on spring-plowed soil.

Tillage

In the preparation of the soil for the sugarbeet crop, all work should be performed in such manner as will minimize losses caused by either wind or water erosion. Plowed soil should offer no channels for rapid runoff, although offering full opportunity for excess rainfall or snow water to drain away from the field. If the soil is sloping, contour working or terracing is recommended. The surface soil should at all times be protected from erosion to the greatest practicable extent. Fall plowing should be done sufficiently early so that oats or some other crop that winterkills can be planted. Before being winterkilled, such a crop will make sufficient growth so that the roots will bind the soil together and the tops will cover and protect the surface without interfering with the spring work in the preparation of the seedbed.

The sugarbeet crop requires adequate and timely attention to the preparation of the seedbed if full and satisfactory stands are to be attained and proper root development facilitated. The seedling is small, the seed or germ being slightly larger in size than a clover seed, and, as with other small-seeded crops, the soil in the seedbed should be fine and firm for proper germination of the seed and emergence of the seedlings. The sugarbeet has a taproot that penetrates deeply within the soil. For proper development of this root the seedbed should be deeper than for other crops.

Farm operators, having intimate knowledge of the soil being worked and the effect of the various tillage implements upon it, should so schedule the various operations that the surface soil may be reduced with a minimum of operations to a deep, relatively fine, firm, but not compacted, seedbed by planting time. The time of year when the soil should be plowed, the depth of plowing, and the number of subsequent workings required to produce a seedbed of the desired characteristics depend to a very large extent upon the type and condition of the soil.

With tractor equipment, early fall plowing to a depth of 8 or 10 inches is generally practicable on the heavier types of mineral soil (fig. 10). Even though a cover crop such as oats may be planted on the fall-plowed soil, the field should be left as rough as possible since freezing and thawing during the fall, winter, and early spring assist materially in breaking up and mellowing the large lumps of soil that were turned up, thereby reducing the amount of work required in the preparation of the seedbed. Were plowing to the same depth to be attempted in the spring when the soil is usually wet, preparation of a seedbed of proper fineness and depth would be very difficult and possibility of unduly compacting the soil would be much greater.

When the sugarbeet crop follows the navy bean crop in the rotation, a considerable number of the growers do not plow the soil either in the fall or in the spring but prepare it for the sugarbeet crop by disking thoroughly shortly before planting and finishing the preparation of the seedbed with a spike-tooth harrow. In some districts this method has met with considerable success.

A once-over method of soil preparation for the sugarbeet crop has been tried on a relatively large scale, and the results obtained have been sufficiently favorable for it to be advocated by certain agencies. In this method the soil is spring plowed. Attached to the plow at the time of plowing and pulled by the same tractor is a device for fining, smoothing, and compacting the soil (harrow, cultipacker, or

combination of cultipacker and spring-tooth harrow) that completes the preparation of the seedbed in one operation. Following such preparation of the soil the sugarbeets are planted without delay. This preparation may be advantageous with some of the lighter types of mineral soil or with soils deficient in organic matter which if fall-plowed would be found following the action of frost during the winter to be nearly as compact in the spring as they were before the fall plowing.

The methods used to prepare the muck, or organic, soils for the sugarbeet crop differ radically from the methods followed on mineral soils. Very often the organic soils are so loose that all tillage operations are pointed toward compacting the soil. Even if it is deemed necessary to plow the muck soil, more work is necessary to firm such a soil than is ordinarily necessary even on the loosest type of mineral soil. The muck soil often becomes so dry and loose that the sugarbeet seedlings may be severely damaged

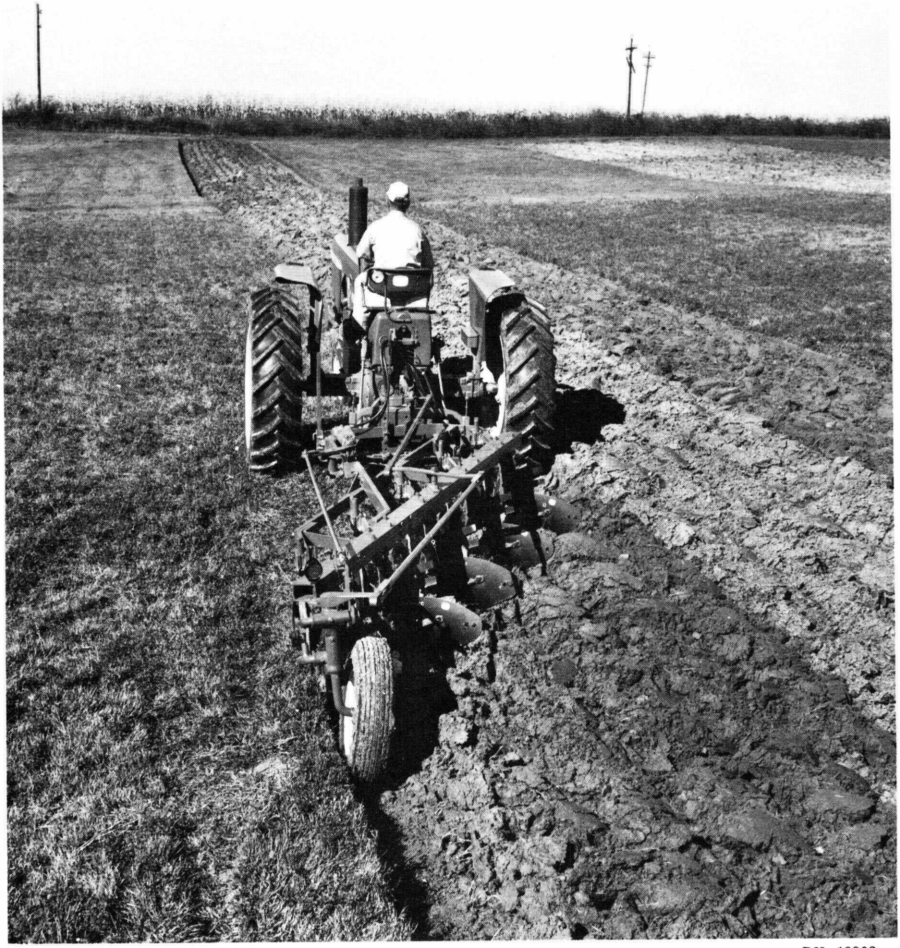

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FIGURE 10.—Plowing with tractor equipment.

or killed by the surface soil blowing away. Prevention of such damage is difficult, but the damage suffered is generally less where the soil has been properly firmed, the crop rows planted at right angles to the wind exposure, and the surface left as irregular as possible.

In the humid area the soil is usually worked to a point where one finel set of operations with a harrow (fig. 11), or a combination of implements (fig. 12), will complete the preparation of the seedbed.

Soil preparation is followed almost immediately by seeding. The advantage of this plan is that, if the work is interrupted by rain, the seed has already been planted on the part of the field that has been finished and the work performed is not lost. Danger of compaction of the soil through repeated operations is also eliminated.

Plant Food Removed

As with other nonleguminous crops, the sugarbeet is classed as soil-depleting. The opinion, however, that the sugarbeet crop is hard upon the soil and that its culture decreases the soil fertility more rapidly than is the case with other nonconserving crops is unwarranted. Chemical analyses showing the quantity of plant nutrients removed from the soil by an average crop of sugarbeets and by comparable yields of wheat, corn, oats, tomatoes, and potatoes, as well as by the legumes, alfalfa and soybeans, do not furnish any basis for stigmatizing the sugarbeet as a "soil robber." No matter what crop is grown, it must not be expected that the soil can continue to produce good crops indefinitely without the use of fertilizers to maintain a proper fertility balance and to replace plant nutrients which have been removed. In the humid area it should be the general practice to apply fertilizers for the production of all crops, whether sugarbeets are grown or not.

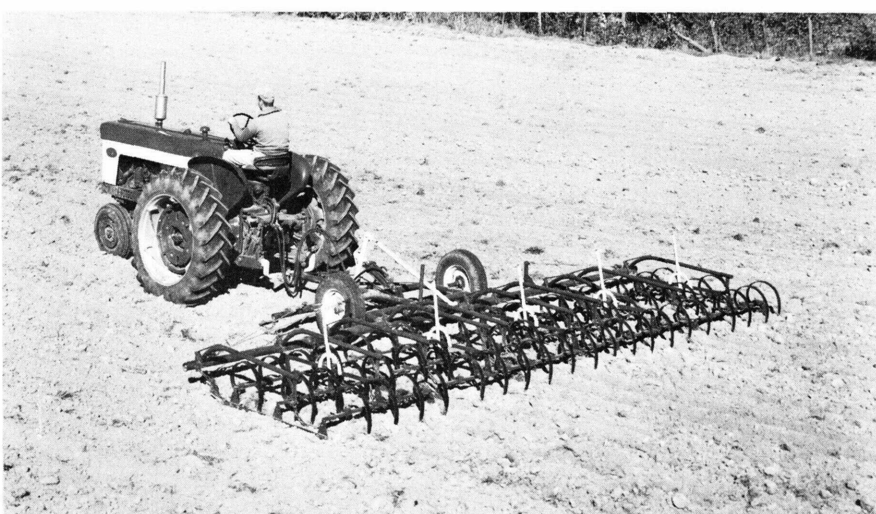

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FIGURE 11.—Preparing the seedbed with a five-section coil-spring harrow.

Fertilization of Sugarbeets

The sugarbeet crop responds definitely to fertilization, and in the humid area where sugarbeets are included in the rotation a large part of the fertilizer used during the rotation is applied to or for the sugarbeet crop.

Barnyard manure, although not in itself a balanced fertilizing material, is an excellent fertilizer for sugarbeets. Sugarbeet growing and livestock or dairy farming go hand-in-hand, as the beet tops make excellent livestock forage and the cattle supply manure for the sugarbeet crop. Not only does the manure application increase the organic content and moisture-holding capacity and improve the tilth of mineral soils, but it also supplies some nitrogen and some of the mineral elements the plants use. On organic soils the application of barnyard manure often promotes desirable bacterial activity within the soil, thereby increasing productiveness.

In some very successful rotations on mineral soils some growers make heavy applications of barnyard manure for sugarbeets in place of turning under green-manure crops. Other growers spread the barnyard manure on the green-manure crop before turning it under, thus hastening the decay in the soil of the organic material.

In the humid area commercial fertilizer is almost always used with the sugarbeet crop (fig. 13). The amount used varies greatly, but experience has shown that heavy applications are profitable. Some growers get excellent returns from applying 1,000 pounds per acre, or more, of a well-balanced commercial fertilizer.

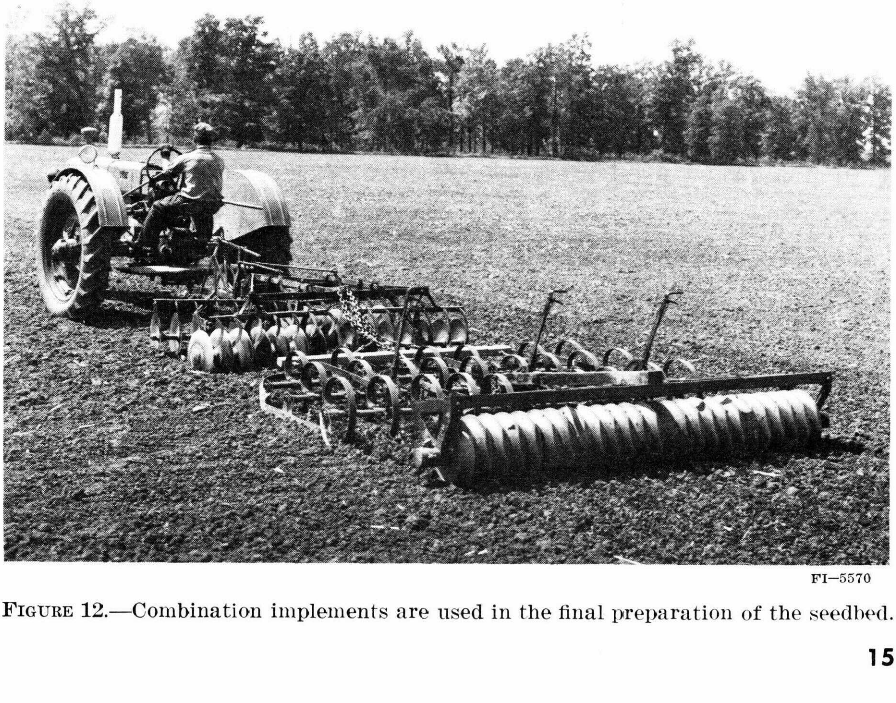

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FIGURE 12.—Combination implements are used in the final preparation of the seedbed.

Commercial fertilizer mixtures that give the best results vary with the soil and the farming system followed. Muck soils usually give the best yields when the mixture contains a high proportion of potash, whereas the mineral soils usually require a greater proportion of phosphoric acid. The lighter mineral soils are more often found to be deficient in nitrogen and potash than the heavier, darker types, but for both types of mineral soils a higher proportion of phosphoric acid than either nitrogen or potash is usually necessary.

The more liberally the mineral soil has been fertilized with barnyard manure, green-manure crops, and legume sods, the less will be the need for applying nitrogen and potash in fertilizer form. Where little manure and no green-manure crops have been used and where legume sods have not been broken regularly, it will be found necessary to apply larger amounts of nitrogen and potash in proportion to the phosphoric acid in the mixture to obtain comparable results.

Fertilizer Placement

The manner in which the fertilizer is applied to the soil and its placement with respect to the seed have appreciable effects upon the yields of sugarbeets. Formerly when applications were from 125 to 250 pounds per acre, the fertilizer was allowed to fall in the seed furrow with the seed at the time of planting. Later, as heavier and heavier applications came into use, such placement of the fertilizer often interfered with germination of the seed, especially if the moisture supply was scanty, and the fertilizer sometimes injured the seedlings. Studies and experience have indicated that the most efficient placement of the fertilizer is in a band close to and slightly below the seed. Most of the beet drills (fig. 14) now on the market are equipped

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FIGURE 13.—The four *center* rows received no fertilizer, whereas the fertilizer was applied to the field on the *right* and *left*.

with devices to accomplish this even with the heavier applications. But many of the growers still prefer to drill part of the application deep into the soil during seedbed preparation and place the rest in a band close to the seed when it is planted. When the application is split in this manner, the mixture applied during soil preparation usually does not contain any nitrogen.

Side Dressing

Supplemental applications of nitrogen may be made to the crop as a side dressing either before or following blocking and thinning. The rate recommended is 40 pounds of elemental nitrogen per acre. The crop responds more quickly to the nitrate forms than to the ammonia. Experimental work and experience in commercial fields indicate that the earlier applications are more effective than the later ones; that if alfalfa or other leguminous crop has been turned under within a year or two of the beet crop, the response from the nitrogen applications may not be so pronounced; and that applications made as late as when the crop is laid by may depress the sucrose content somewhat and reduce sugar recovery.

The dry forms of nitrogenous fertilizer used for side dressing may be applied either with fertilizer attachments of a beet drill so offset that the furrowers of the drill do not run upon the beet rows, or by means of special attachments placed on a beet cultivator.

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FIGURE 14.—Planting and fertilizing, at uniform-spaced intervals, using a four-row precision drill.

When the crop is sidedressed with dry fertilizer, the material is usually placed as near the row and as deep as possible without causing extensive root pruning, although good results have been obtained when it has been drilled in between alternate rows.

Although side dressing of sugarbeets with fertilizer is not as yet general, the results that have been obtained indicate that it may become a desirable operation if soil-building crops and manures are not used regularly and especially if the sugarbeet crop lags in growth or the foliage shows lack of nitrogen.

Minor Elements

With the continued cultivation of the soil and the removal of the crops grown, some of the mineral elements that the plants use in relatively small quantities may become deficient. Definite indications of boron and manganese deficiencies have been found in sugarbeet fields on mineral soil in the humid area. Muck soils may be deficient in certain minor elements in the virgin state. Copper sulfate, when applied to some muck soils, and magnesium, when applied to some muck and some mineral soils under certain conditions, have had beneficial effects upon the crop, thus indicating deficiency in these elements.

Boron deficiency is ordinarily found in Michigan on the lighter, more gravelly types of mineral soils and in Wisconsin on the heavier soils, such as those at the bottoms of swales. The lack of boron is indicated by the cessation of top growth and the blackening and blighting of the inner, unfolding beet leaves; transverse ladderlike marks appear on the groove of the leaf petioles; and the flesh of the beet root becomes discolored. Affected plants may lose their tops and small accessory buds may start feebly, making the sugarbeet plant look as though it had been injured by trampling. The leaf symptoms commonly show up late in July and in August and seem to be correlated with dry soil conditions. Manganese deficiency is indicated by an unhealthy, light yellow-green color of the foliage and usually by a very definite retardation in the rate of growth.

Minor-element deficiencies may be corrected by the application of small amounts of the minor element needed. Boron deficiency may usually be corrected by the application of as little as 10 pounds of borax per acre. If the soil has a strong binding action on boron or is alkaline, it may be necessary to apply as much as 50 pounds per acre. Care must be exercised not to apply boron in an excessive amount, because some crops, such as corn and potatoes, are sensitive to this chemical element. Manganese deficiency may also be corrected by applying from 10 to 50 pounds of manganese sulfate per acre (fig. 15). If copper applications are found to have beneficial effects when applied to muck soils, the recommended rate is 50 pounds of copper sulfate per acre. Where magnesium is needed, either on the muck or mineral soils, this element may be supplied through the application of several hundred pounds of dolomitic limestone per acre, the amount applied being limited only by the change caused in the pH value of the soil.

The use of minor elements in the humid area has become so common that mixed fertilizers containing the desired percentage of any particular minor element or elements, except possibly magnesium, may now be purchased from many of the companies engaged in the manufacture of fertilizers.

FIGURE 15.—The rows on the *right* and *left* of the four *center* rows received an application of manganese sulfate.

Soil Amendments

Soil amendments are materials that are applied to the soil to improve its structure or to produce other effects whereby the crops are better able to utilize the plant nutrients of the soil.

Under continuous cultivation and partially as the result of the application of commercial fertilizers, soils in the humid area tend to become acid. The application of lime, as finely ground limestone, hydrated lime, or factory waste lime (fig. 16), to correct the acidity of the soil is the most common of all soil amendment treatments. Although calcium, derived from the lime, is necessary in plant growth and considerable amounts are removed by certain crops, soils are limed primarily to correct soil acidity, and the amount of lime applied should be determined by the change in soil reaction desired. Care should be exercised to avoid excess applications of lime because phosphate, as well as the minor elements, boron and manganese, become less available if the soil is made strongly alkaline. If the soil needs lime, the common practice is to apply the lime to the soil for the alfalfa or clover crop included in the rotation, the sugarbeets and other crops in the rotation benefiting in turn from the application.

FIGURE 16.—Spreading factory waste lime on the soil.

The practice of applying common salt to the soil prior to growing a crop of sugarbeets is common in some districts in the humid area. The benefits derived from the application of common salt to muck soils have resulted in general recommendations being made for its use at the rate of 500 pounds or more per acre. Recommendation is not made for the use of salt on mineral soils, although in a few beet-growing districts beneficial effects apparently have been obtained. No deleterious effect upon mineral soil structure or adverse effect upon the crops that follow the sugarbeets have been shown. Common salt, however, must be considered as a soil amendment, and its use should be restricted to those soils and those sections in which definite benefit is derived by the sugarbeet crop. When common salt is used it is ordinarily applied to the soil with a lime spreader shortly before the crop is planted and worked into the soil during the seedbed preparation.

Machinery and Labor Requirements

In comparison with other field crops in the humid area, sugarbeets in the past have been an expensive crop to grow, requiring much hand labor. Progressive mechanization of the operations in crop production has already reduced the amount of hand labor required and gives promise of still greater reduction.

Farm management studies made at the Michigan State Agricultural Experiment Station show that the total number of hours of labor required to produce an acre of sugarbeets in the humid area decreased from 125 (75 hand and 50 machine) in 1915 to 99 (70 hand and 29 machine) in 1935. In 1946 the number of hours of labor required per acre had further declined to 71, of which 60 hours were hand labor, chiefly required for blocking, thinning, pulling, and topping the beets. At the present time, with the crop being harvested mechanically and with machine work being in considerable part substituted for hand blocking and thinning, the number of hours of hand labor is much less.

The general use of the tractor, processed seed, and monogerm varieties has brought about some decisive changes in sugarbeet machinery. Low-capacity implements are being replaced by gang plows, combination implements for seedbed preparation, multiple-row and precision drills, multiple-row cultivators, stand-reducing implements, and mechanical harvesters.

Commercial seed graded to fairly uniform size is now planted with precision drills. The seeds are dropped 1 to 4 inches apart (fig. 17). The sparse distribution of seedlings along the row and the absence of clumps of plants make it practicable to use stand-reducing machines or long-handled hoes. These stand-reducing methods are replacing hand labor, once necessary for blocking and thinning. Great progress is being made in the development of field practices that will reduce labor requirements for thinning and weeding sugarbeets.

Weed Control

Within the past few years chemical aids to agriculture in the form of herbicides have been developed. When properly used, these may aid greatly in eliminating the weed problem from the sugarbeet fields in the humid area. Thus, 2,4–D may be used at some place in the

rotation for the elimination of bindweed and other perennial broadleaved weeds from the field. Several different compounds have been developed for ridding fields of perennial grasses.

Preemergence Treatment.—Annual weeds and grasses often may be practically eliminated or at least greatly reduced by spraying the entire soil surface with compounds or mixtures of compounds shortly before the beet seedlings appear. At the present time, the most promising results in the humid area are being obtained with mixtures of TCA (trichloroacetate) and other herbicides.

Postemergence Treatment.—Common salt is also sometimes used as a herbicide after the sugarbeet plants are up. Spraying is usually done when 4 to 6 leaves have developed. The sugarbeet has greater tolerance for salt than many broadleaved weeds and certain of the grasses, and it is therefore possible to spray the beets with a strong salt solution. Two pounds of salt to a gallon of water are applied at the rate of 100 to 300 gallons of the strong brine per acre. The spray is applied in as narrow a band as possible directly upon the rows. If the weeds and grasses are very small, the strong salt solution will kill them without serious injury being done to the sugarbeets.

A fully satisfactory chemical control of weeds in sugarbeets has not been developed. New compounds are being continually investigated. The grower should consult with his county agricultural agent or the fieldman of the beet-sugar company for latest developments.

Sugarbeet Seed

The sugarbeet seed, as it matures on the plant (fig. 18) and is harvested, is not a seed like a pea or bean but is a seed ball often containing two or more true seeds (fig. 19). The sugarbeet flowers grow singly or in clusters of 2 to 7 or more, the flower parts being fused

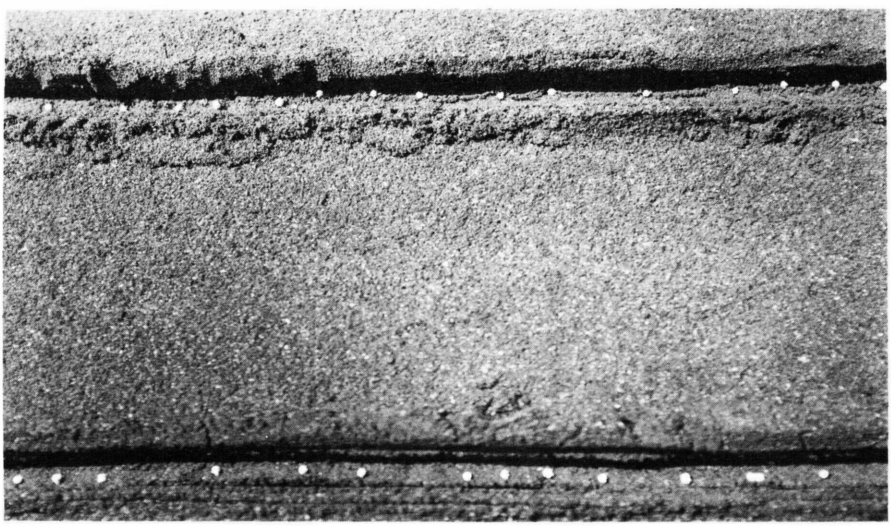

FIGURE 17.—Processed seed as dropped in the seed furrow by a precision drill. The seed has been coated with a white dust, to contrast with the soil.

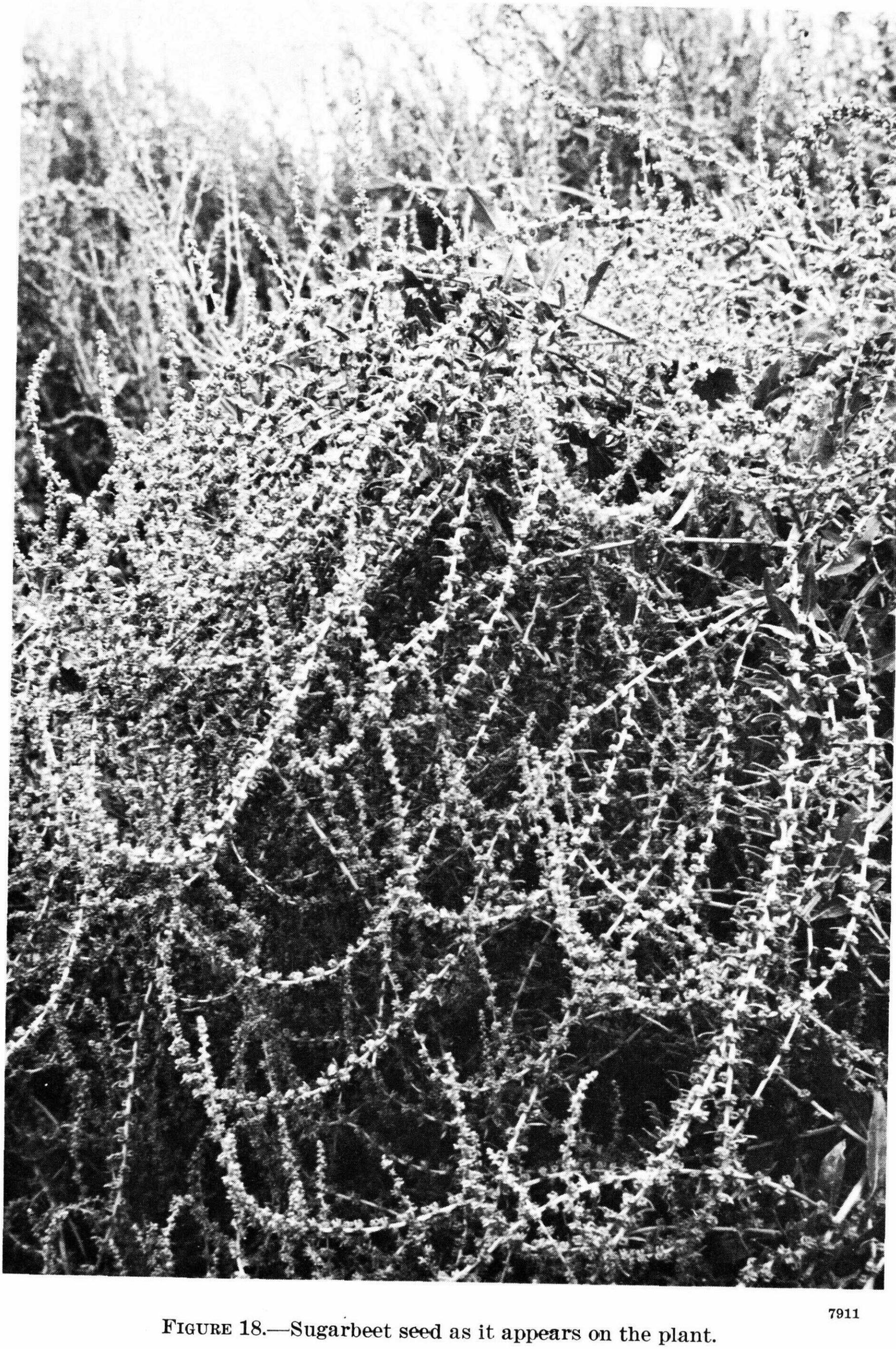

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FIGURE 18.—Sugarbeet seed as it appears on the plant.

at the base. At maturity they dry to form the seed ball, or multigerm seed.

During the decade 1950–60, sugarbeet varieties which produce single-seeded fruits were developed. This seed type is known as monogerm. Monogerm varieties that are productive and disease resistant are being developed for all sugarbeet districts. When monogerm seed is planted singly with the proper spacing along the row, the resulting seedlings will occur at such intervals that will greatly reduce the labor requirements of thinning and weeding.

The sugarbeet seed planted in the humid area at the present time is produced in the United States. The varieties used are those that are resistant to leaf spot, or blight, and capable of giving good yields of high-quality roots under conditions of severe leaf spot exposure.

Time of Planting

For the best development, the sugarbeet plant needs a long growing season. Although the planting period in the humid area extends from early in April to the last of May, higher yields are obtained from the earlier plantings. In the humid area late March and April conditions are often cold and wet and for that reason seedbeds can usually be prepared more quickly and the planting done earlier on fall-plowed than on spring-plowed soil. The higher yields obtained from the earlier plantings represent not only the differences attributable to a longer period for growth but also greater production and storage of food reserves late in the season that come from the larger plant units.

Depth of Planting

Many failures in obtaining a satisfactory stand of sugarbeets in the humid area have been blamed upon improper planting depth when some other condition, as a poorly prepared seedbed, is primarily responsible. Experiments indicate that, considering the size

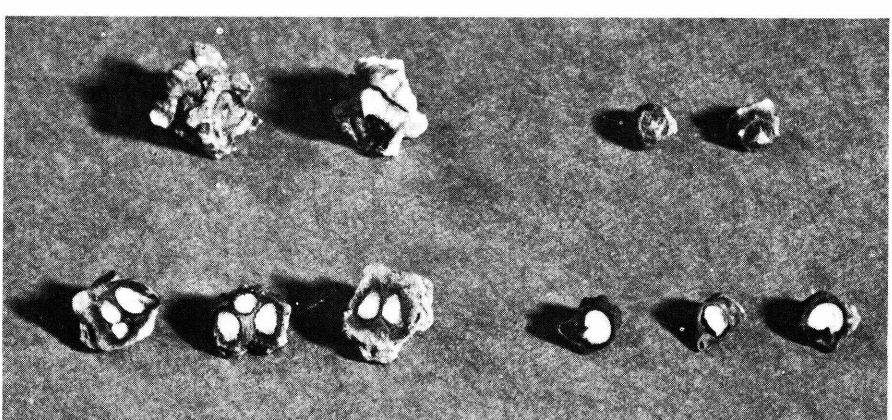

FIGURE 19.—Sugarbeet seed before (*upper row*) and after (*lower row*) processing. Note the size of the seed ball and the number of seeds held within the ball.

of the germ, or seed, there is a considerable range in the depth to which the seed pieces may be planted without materially affecting the emergence of the seedlings. Nevertheless, planting depths of more than 1½ inches are not recommended.

In the humid area the soil is usually quite moist in the spring and warms slowly, so the early plantings should be comparatively shallow—about three-fourths of an inch. As the season advances and the soil becomes warmer and the surface drier, the planting depth may be greater, but it is usually inadvisable to place the processed seed more than 1 to 1¼ inches below the surface. With all depths of planting, the soil below and above the seed pieces should be firm enough to give good contact between the seed piece and the moist soil and thus insure the rapid transfer of moisture from the soil to the seed piece.

In the latter part of the planting season, dashing rains often occur that cause crusting of the soil. When such crusts form before the emergence of the seedlings, appropriate operations should be undertaken to break the crust in order that the seedlings, which are very small, may be able to emerge.

Row Width

The sugarbeet crop is always grown in rows to permit intertilling. During the time when all machine work was performed by horse-drawn equipment and hand labor was plentiful, the beets were planted in relatively narrow rows, sometimes as close as 18 inches but generally 20 to 22 inches apart. With the progressive mechanization of the crop the row width has become progressively greater, until at the present time most of the sugarbeet crop in the humid area is grown in rows 28 or more inches apart. Obviously, wide rows mean fewer trips across the field with the sugarbeet harvester. A compelling reason for wider rows for sugarbeets is that these widths are used with other intertilled crops in the rotation. If the sugarbeets have the same row width as used with the bean crop, for example, the tractor-drawn cultivator can be used on the two crops without adjustment of tools.

Increase in row width is associated with some loss in efficiency of use of field space, and this may be reflected in somewhat lower crop yields as compared with the yields obtainable from narrower rows. The trend toward wide rows, therefore, reflects a compromise in which the grower is willing to accept a lower yield in return for greater ease in use of mechanical equipment.

Quantity of Seed Planted

The quantity of seed to plant per acre for best results depends upon climatic and soil conditions, upon the weed problem, and upon the row width. When whole seed was used and the rows were relatively narrow and the blocking and thinning performed by hand, the amount recommended was from 12 to 15 pounds per acre. With processed seed and the relatively wider rows and much of the spring work performed mechanically, the recommended rate varies from 4 to 6 pounds per acre, depending to some extent upon the condition of the seedbed and the anticipated weed infestation, more seed being recommended under adverse conditions.

Under favorable soil conditions it is believed that 6 to 12 pieces of processed seed or 6 to 12 monogerm seeds per foot of row, each piece or each seed containing a viable germ, will result in the emergence of sufficient seedlings for stand reduction by machine or long-handled hoe.

Blocking and Thinning, or Stand Reduction

The introduction and use of processed seed, together with the great increase in the mechanization of the spring work, brought about great changes in the manner in which the work in the early part of the season is performed; although it is probable that some part of the beet acreage in the humid area will still be cared for by hand.

As explained previously, the true seed of the sugarbeet is small, the seedling relatively weak, and emergence usually imperfect. An excess of seed is planted to assure sufficient seedlings to give the desired permanent stand. The initial stand obtained is usually thicker than the permanent stand desired, and it is necessary to remove the excess seedlings either by hand or machine before competition sets in and hinders the crop.

Formerly, when multigerm seed was used, the blocking and thinning were performed almost entirely by hand, although efforts were made at various times and in various ways to reduce the hand labor of the operations (fig. 20). Since the use of processed seed and monogerm varieties has become general, several types of stand-reducing machines and field practices have been developed that promise to eliminate practically all hand labor connected with blocking and thinning the beets, although some hand labor may still be necessary for hoeing.

For mechanical stand reduction to be a complete success, the initial stand of seedlings must be suffi-

Photo by courtesy of the Utah-Idaho Sugar Co.

FIGURE 20.—A six-row thinning machine.

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ciently thick to undergo the several operations performed with the stand-reducing machines. These remove surplus plants and eliminate weeds and grasses in the row. A final stand of seedlings averaging, if possible, 100 to 150 per 100 feet of row should be left.

Time of Stand Reduction

Formerly when stand reduction of the sugarbeets was accomplished entirely by hand through blocking and thinning and the entire operation was normally accomplished at one time, effort was made to have the work done when the beets were in the 4- to 6-leaf stage. Earlier thinning, although giving good results, was not regarded as practicable on account of the small size of the seedlings, and later thinning, when the plants were larger and interplant competition had set in (fig. 21), did not give as good results. In order to have the hand blocking and thinning done as soon as the beets reached the proper size, the beet-sugar-company field supervisors strove to have the plantings in their districts staggered so that not too many acres of beets would reach the thinning stage at the same time. Even on farms where large acreages were grown, only 6 to 10 acres would be planted at a time—all because of the importance of blocking and thinning the beets at the proper stage of growth.

Now that processed seed, monogerm varieties, precision drills, herbicides, and mechanical stand reducers are being used, the picture has changed completely. No longer is it necessary to stagger the plantings in districts or on farms; all acreage may be planted as early as possible, for the mechanical stand reducers have freed the beet grower from the necessity of waiting until hand labor is available. Neither is it so necessary to have blocking and thinning of sugarbeets performed at a definite stage of plant growth, for with precision drilling of processed seed and monogerm varieties, many of the plants stand singly, so that serious interplant competition does not set in as early as was the case when 12 to 15 pounds of multigerm seed were planted per acre.

Mechanical stand reduction has also changed the picture in another way. Previously, the stage of plant growth was of prime importance and the operations of blocking and thinning were performed either by

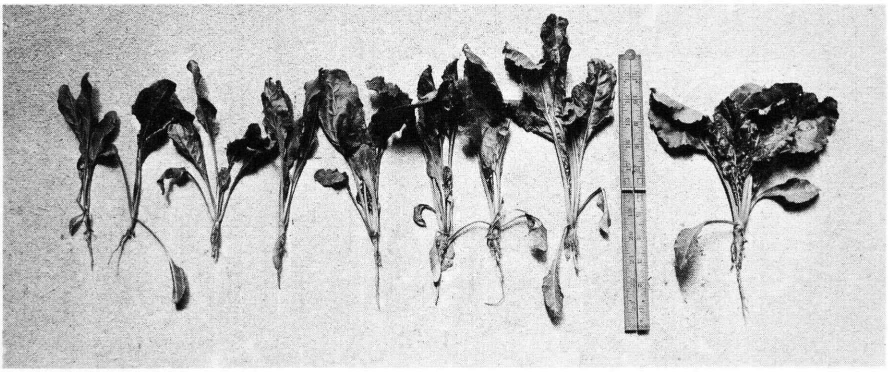

FIGURE 21.—The sugarbeet at the *right* of ruler was thinned in the 4-leaf stage. It has made greater growth than those at *left* of ruler, thinned at the 8-leaf stage. All were planted at the same time.

one laborer as one operation or by two laborers—one to block and the other to thin the seedlings. With the mechanical stand reducers the job may begin when the plants are quite small, and it is entirely practicable to accomplish the desired stand reduction by stages—by different trips of the machine down the rows. It is possible for the grower to observe the results from each operation. Weeds in the row are eliminated by the mechanical thinner as well as many of the weaker beet plants, until the plant population has been reduced to the desired number per 100 feet of row.

The down-the-row mechanical stand reducers with the interchangeable toolheads have met with greater favor among the sugarbeet growers in the humid area than the earlier methods of cultivation across the rows.

The down-the-row machines have toolheads equipped with ¼-inch round-spring steel finger weeders. Toolheads equipped with blocking knives that cut out definite portions of the beet row also can be attached to replace the weeders. The toolhead selected for use depends upon the initial stand of seedlings, the size of the sugarbeet plants, and the weeds present. It is common practice to go over the field first while the beets are still relatively small with the stand reducer equipped with the finger weeder toolheads. This operation must be done very carefully, as in the earlier stages of plant growth it is very easy to remove the small beet plants. Later, as the beets become more firmly attached to the soil and the stand can be more easily seen, the blocking-knife toolhead may be used. For the first time over with the blocking-knife toolhead, the knives may cut out 50 percent of the beet row in 3- to 4-inch blocks, leaving undisturbed blocks of approximately the same size. For the second time over with the blocking-knife toolhead, the wheel used has more but shorter knives and is used upon the row in the opposite direction from the first blocking operation. This operation also cuts out approximately 50 percent of the seedlings remaining in the row but operates to divide or cut off the ends of the blocks left by the first time over with the blocking knives.

Spacing the Plants

When unprocessed seed was used and the seedlings were blocked and thinned by hand, it was possible to specify to some extent the spacing pattern of the plants. This often resulted in a definite uniformity or regularity of the plants in the beetfield. With processed seed and the reduction in stand being accomplished at random by mechanical means, the spacing of the plants that remain is very irregular. At least 100 to 150 plants per 100 feet of row should remain after stand-reduction operations and these should be spread along the row as uniformly as possible. The occurrence of 2 or 3 plants very close together in 1 place has very little influence upon the final acre yield if there are not more than 20 to 30 percent of such hills.

Cultivation

Cultivation soon after the seedlings have emerged from the soil is usually desirable for the purpose of stirring to speed the drying of the surface soil as well as to destroy weed seedlings. This cultivation is accomplished in the conventional manner by using knives or disks on a 4- to 6-row cultivator, set to cut as close to the row as possible. If

the stand-reduction operations are to be accomplished by hand labor, the row of beet seedlings will be left standing on a low, narrow ridge of soil by this operation, but if stand-reducing machines are to be used, the loose soil is moved back to support and protect the narrow ridge during the stand-reducing operations.

Following blocking and thinning or stand reduction by machine, when the plants remaining have become erect, it is customary to cultivate the beets again, and during this operation to shift soil back into the row so that grass and weed seedlings which may have started are covered. When this operation is carefully performed, the weed population of the field is greatly reduced (fig. 22).

The number of cultivations during the rest of the season is determined by the number of rains received and the weeds that emerge following the rains. During each of the later cultivations the weeds between the rows are cut off and soil is pushed into the row to cover such weeds as may have started. As the season advances and the root systems become more extensive, cultivation should be very shallow to avoid injury to the feeding roots. Cultivation should be discontinued when the foliage is sufficiently large to be injured by machines (fig. 23).

Harvest

Sugarbeet harvest in the humid area is ordinarily deferred as long as possible, to permit the crop to make the greatest possible growth. Harvest generally starts late in September or early in October and is carried forward rapidly in order that the job may be finished before the soil freezes. Mechanical harvesting and immediate truck delivery have not only very definitely reduced the amount of hand labor involved but have shortened the time required to harvest the crop and deliver it to the factory. Formerly, when the beets were lifted by horse-drawn machines and pulled and topped by hand (fig. 24), the

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FIGURE 22.—Twelve-row cultivator in sugarbeet field.

amount of labor available determined the rate of harvest. At the present time, the acreage is harvested mechanically, and the rate of harvest is determined by the number of machines operating. Some machines load the roots directly into the trucks or into carts from which they are loaded into the trucks (figs. 25 and 26).

Delivery of the Crop

Formerly when horse-drawn implements were used in harvesting the sugarbeet crop and the pulling and topping were done by hand, the crop was also delivered to the weigh station by horse-drawn equipment. In those times the delivery of the crop was often delayed until all the beets had been harvested, the roots being piled in the fields and covered with the beet tops to prevent shrinkage. Delivery to the factory before the advent of cold weather was much slower, and the beets could be processed almost as fast as delivered. With the increasing use of the truck for beet hauling, delivery of the crop has become more rapid so that now the crop is delivered almost as fast as harvested and more rapidly than the beets can be processed. This has resulted in many of the beets being placed in storage piles at the factory (fig. 27). Although the grower benefited by the more rapid delivery of the crop, losses caused by heating and spoilage of the beets in the storage piles became a serious problem to the processor. At the present time, in order that the beets may be received and stored as rapidly as harvested with a minimum danger of loss from spoilage, many of the beet-sugar factories have installed equipment for ventilating and cooling the piles of stored beets until such time as they may be processed (fig. 1).

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FIGURE 23.—Cultivating sugarbeets with a 25-foot harroweeder.

FIGURE 24.—When sugarbeets were topped by hand, a large amount of labor was necessary in the harvest of the crop.

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FIGURE 25.—A sugarbeet harvester that simultaneously tops the sugarbeets, digs, cleans, and loads the roots into a truck.

BN—19904

FIGURE 26.—After topping, this type of harvester digs one or two rows of sugarbeets at a time and elevates the roots into a truck.

FIGURE 27.—Sugarbeets being piled at the beet-sugar factory.

Diseases [2]

Cercospora Leaf Spot

Cercospora leaf spot of sugarbeets is characterized by small circular spots, approximately one-eighth inch in diameter, on the leaf blades (fig. 28). Leafstalks are also attacked. Under severe attacks by the fungus, the spots run together; severely affected leaves dry and turn brown. The attack may be so severe that the entire field looks as if scorched by fire. The disease in this stage is commonly referred to as blight (fig. 29). The disease starts on the older leaves and advances to the younger leaves.

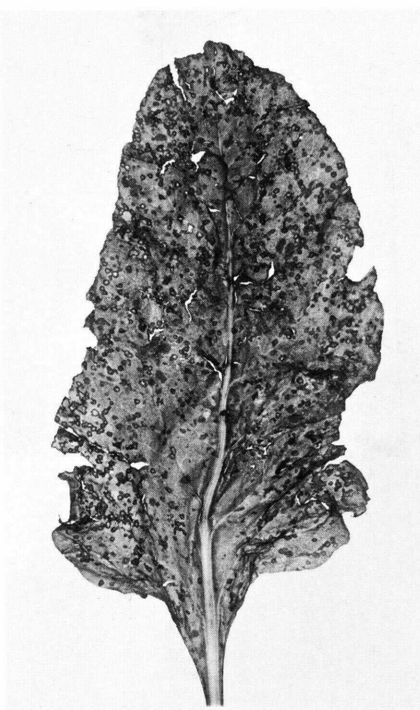
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FIGURE 28.—Cercospora leaf spot of sugarbeet.

[2] Prepared by G. H. Coons, formerly principal pathologist, and Dewey Stewart, research agronomist, Crops Research Division.

Under conditions that favor disease outbreaks, a field may show a succession of blighting, apparent recovery, and another wave of blighting, and so on, until cool weather in the fall checks the disease.

The fungus that causes leaf spot is present on the seed; it also lives over the winter on trash and debris from a previous beet crop. Although severe blighting may not occur every season and the farmer may not notice leaf spot in his sugarbeet field, the disease is present to some extent every year.

Climatic conditions determine the severity of the disease unless leaf-spot-resistant varieties of beets are planted. Rainy periods, spaced a week or two apart, and high temperatures in the first half of the growing season allow the fungus to increase rapidly. It is checked by cool spring or summer conditions.

Where wholesale blighting of the leaves occurs early, both root weight and sugar storage are lowered. Late attacks that come after the

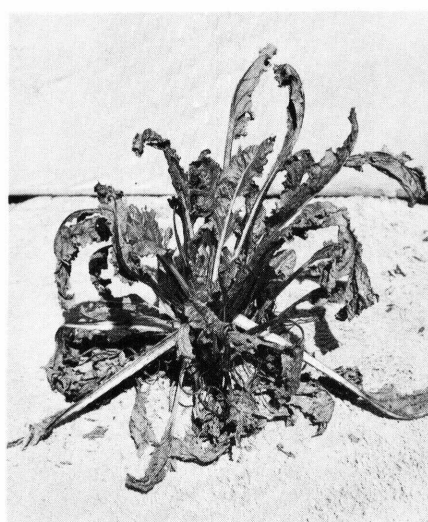
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FIGURE 29.—Blighting stage of leaf spot.

root growth is largely made sharply decrease sugar storage.

Leaf spot can be controlled by a rotation system in which sugarbeets do not follow sugarbeets. In general, an interval of more than 3 years should come between sugarbeet crops. This rotation system should be followed even though leaf-spot-resistant varieties are planted. Seed treatment is undoubtedly of benefit but does not control the disease.

Leaf-spot-resistant varieties of beets have been developed for use in the humid area. Some spotting of the leaves will occur, but they do not show the excessive burning and foliage destruction of susceptible varieties. In productivity they compare favorably with old varieties, and under leaf spot conditions the resistant hybrids produce 10 to 15 percent more sugar per acre. The breeding work is still going on, so that it may be expected that introduction of improved varieties will continue.

Black Root

Seedling diseases that reduce or even totally destroy stands of young sugarbeet plants as they emerge from the soil, are called by farmers damping-off, or, more commonly, black root (fig. 30). The disease takes on two forms—acute and chronic. In the acute attacks, the seedlings are killed during germination or in a week or two after their emergence from the soil. This is the common cause of poor stands.

Often sugarbeet seedlings are not killed within a week or two after emergence, but do not grow thriftily. On examination it will be found that all or nearly all of the lateral roots and the terminal part of the taproot are killed and blackened. The young plant is not able to establish and maintain proper root development to absorb food and water from the soil. This type of black root may persist throughout the life of the plant, and is called the chronic form. The leaves of young plants affected with the chronic form of black root may become mottled, simulating a mosaic. Affected plants remain dwarfed and stunted and seldom reach marketable size.

Black root is especially severe in the humid area. If weather conditions are wetter than normal, stands of sugarbeets may be extremely irregular. The fungi causing black root may have attacked the emerging sprouts and killed

5193

FIGURE 30.—Damping-off of sugarbeet seedlings (black root).

them. If some plants do emerge, many die within 2 or 3 weeks if weather conditions continue favorable for black root development. Other plants may persist but they are subject to the chronic form of the disease.

Effective control of the acute form of black root is dependent upon several practices. Alfalfa, sweetclover, red clover, and other leguminous crops are also subject to black root. If sugarbeets follow a legume in the rotation, the legume should be plowed under in early fall in order to exhaust the food supply of the fungi causing black root and thus reduce their prevalence by the time the sugarbeets are planted in the spring. The sugarbeet crop should be grown on fields of high fertility that have good surface drainage. Fertilizer, especially phosphate, serves not only to increase beet yields by improving plant nutrition, but increases the resistance of the sugarbeet crop to the black root fungi. One organism that causes black root is seedborne. Other species occur naturally in the soil. Seed treatment checks the seed-borne fungus and protects the young plant from the black root fungi in the soil. Nonmetallic fungicides are generally used for seed treatment. As soon as rows can be followed in the field, a cultivation should be given to assist in soil aeration. Black-root-resistant varieties of sugarbeets are being developed. These are very effective against the chronic form of the disease.

Rhizoctonia Root Rot

Although the sugarbeet is subject to many types of root rot, rhizoctonia root rot has caused the most serious damage in the humid area. This rot commonly shows up fairly late in the summer and usually takes the form of a crown rot. Clefts appear in the root at or near the crown (fig. 31). The disease is first noted in the field by the presence of occasional plants with older leaves that are dying. Wilting and death of the younger leaves follow this stage. Roots of affected plants are found to be partially or completely decayed, the tissue being blackish brown. Rather coarse brown threads of the fungus can be seen on the roots, often filling the clefts as a weblike brown skein.

Several plants adjacent to each other in the row may show rhizoctonia root rot. After killing the root of a plant, the fungus invades the lower leaves and moves from these to the lower leaves of a neighboring plant, thus spreading along the row.

Such preventive measures as crop rotation in which the sugarbeets follow corn or other nonsusceptible crop, good soil drainage, proper fertilization, and prompt cultivation are the chief means used to control the disease.

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FIGURE 31.—Rhizoctonia crown rot of sugarbeet.

Insects and Their Control [3]

A number of insects are known to feed on the foliage or roots of sugarbeets grown in the North Central States. Severe damage occasionally results from the attack of certain of these pests the more destructive of which are the alfalfa looper, aphids, armyworms, the beet leafhopper, blister beetles, cutworms, flea beetles, the garden symphylan, grasshoppers, lygus bugs, spider mites, the spinach leaf miner, the sugarbeet root maggot, webworms, white grubs, and wireworms. Insecticides often are needed to control these pests and no single insecticide will control all of them.

Precautions

Insecticides are poisonous to man and animals. Handle them with care. Follow all directions and heed all precautions on container labels.

Keep insecticides in closed, well-labeled containers in a dry place where they will not contaminate food or feed and where children and pets cannot reach them.

In handling any insecticide avoid repeated or prolonged contact with the skin, and avoid prolonged inhalation of dusts and mists. Wash hands and face before eating or smoking.

Dieldrin, can be absorbed directly through the skin in harmful quantities. When working with this insecticide in any form and when working with any liquid concentrated insecticide, avoid spilling them on the skin. Keep them out of the eyes, nose, and mouth. If you spill any on the skin or clothing, wash it off and change clothing immediately. If it gets in your eyes, rinse with plenty of water for 15 minutes and get medical attention.

Demeton, Di-Syston, parathion, phosphamidon, and TEPP are extremely poisonous and may be fatal if swallowed, inhaled, or absorbed through the skin. Carbophenothion is highly toxic if inhaled or swallowed. These highly toxic insecticides should be applied only by a person thoroughly familiar with their hazards and who will assume full responsibility for safe use and comply with all the precautions on the labels.

Do not apply demeton, Di-Syston, or phosphamidon to sugarbeet within 30 days before harvest or before feeding to livestock, trichlorfon within 28 days, parathion within 15 days, carbonphenothion or carbaryl within 14 days, naled within 5 days, or TEPP within 3 days before harvest or feeding. Trichlorfon may be applied up to 14 days before harvest if tops are not to be fed to livestock. Do not feed to dairy animals any foliage treated with DDT or dieldrin.

To protect water resources, fish, and wildlife, be careful not to contaminate streams, lakes, or ponds with insecticides. Do not clean spraying equipment or dump excess spray material near such water. Avoid contaminating pasture grass, forage crops, or feed by drift of sprays or dusts.

Alfalfa Looper

This insect feeds primarily on such forage crops as alfalfa and clover, but sometimes the larvae will migrate from an alfalfa field to a nearby sugarbeet field after a cutting of hay has been made. It is a chewing insect, and if an infestation is heavy, can cause serious damage to foliage. Full-grown larvae are 1 to 1¼ inches long, and may be any shade of green with white lines or markings along the sides. There are two or more generations a year in most areas.

Control.—Strip spray along the edge of the field with parathion at

[3] This section was prepared by Kenneth E. Gibson, Entomology Research Division, Agr. Res. Serv.

0.5 pound per acre, trichlorfon at 1.5 pounds, or dust with parathion at the above dosages of active ingredient. These dosages need to be applied in 30 to 35 gallons of spray or 20 to 30 pounds of dust per acre to obtain good coverage.

Aphids

The bean aphid, which is black in color, and the green peach aphid, which is a light yellowish-green, are occasional pests of sugarbeets. They are sucking insects and usually are found on the foliage. They damage the plants by sucking juices from the leaves and by transmitting certain virus diseases such as beet yellows. When aphids colonize on the sugarbeet plants and large numbers are produced, their direct feeding injury may result in retarded growth and cause the leaves to pucker and curl downward. Intensive feeding may cause the leaves to dry up and die.

Control.—Aphids may be controlled with demeton at 0.5 pound per acre in emulsion spray, parathion at 0.5 pound per acre in sprays or dusts, TEPP at 1 pound per acre in dust or 0.4 pound in emulsion spray, or Di-Syston at 1 pound per acre in granules. The Di-Syston is scattered along the top of the row. The other materials are applied to the foliage in 30 to 35 gallons of spray or 20 to 30 pounds of dust per acre beginning when the aphids appear.

Armyworms

There are several species of cutwormlike insects, called armyworms, which sometimes move into sugarbeet fields in large numbers and which may cause serious damage by eating the foliage. Sometimes the beet armyworm and the yellow-striped armyworm (fig. 32) will also feed on the roots.

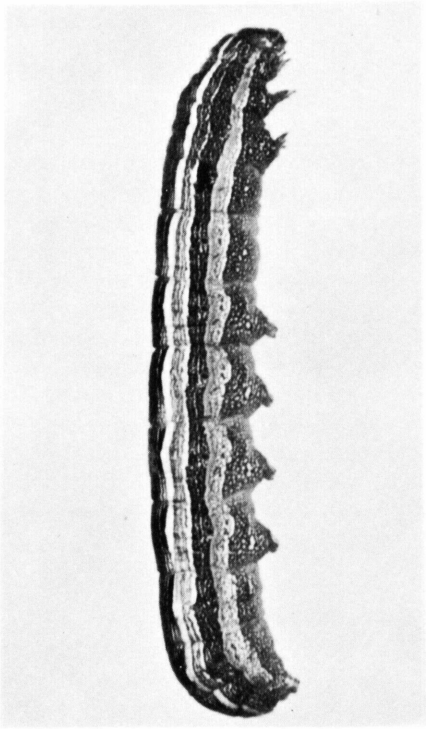

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FIGURE 32.—The yellow-striped armyworm. Twice natural size.

Control.—Armyworms feeding on the foliage may be controlled by spraying or dusting the foliage at 0.5 pound of parathion per acre, as recommended for aphids above. Trichlorfon can also be used as a foliar spray at the rate of 1.5 pounds per acre. Large numbers of armyworms on the march may be trapped and destroyed by plowing a furrow around the field, turning the soil away from the field.

Beet Leafhopper

The beet leafhopper is a small, nervous, fast-moving insect, about ½ inch long, slender, and tan- or buff-colored. It is a sun-loving, desert insect and prefers an environment of low humidity and relatively high temperature. It is the only

known carrier of the virus of curly top and poses a potential annual threat to sugarbeets in areas where it occurs and where varieties are grown that are susceptible to curly top.

Control.—No satisfactory control for this insect has yet been developed. Spring surveys made before planting time, which yield information as to the probable magnitude of the infestation and approximate time of movement into sugarbeet-growing areas, are helpful to growers in planning planting dates and cultural practices so as to minimize the incidence and spread of the disease.

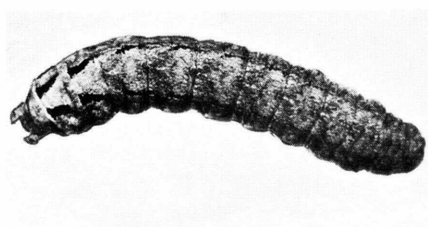
Blister Beetles

Adult blister beetles vary in color from gray to black and are frequently spotted or striped. They are slender beetles, usually from 1/2 to 1 inch long and with rather soft wing covers. Infestations frequently follow heavy depositions of grasshopper eggs, upon which the subterranean blister beetle larvae of many species feed. Occasionally, they move in large bands into a sugarbeet field to feed. They may eat the foliage of the plants in a short time and leave as suddenly as they came.

Control.—They are pests only in the adult form and can be controlled with a foliar application of parathion dust or spray at the rate of 0.5 pound of toxicant per acre, or carbaryl at 1 pound.

Cutworms

Cutworms, which are the larvae of several species of moths, are chewing insects that ordinarily damage sugarbeets by cutting off the stems of young plants at, or slightly below, the soil surface. They generally feed at night, and in the daytime they rest in a curled-up position just below the surface of the ground. Their presence may be indicated by the wilted beet plants they cut off in their feeding. Cutworms vary in color from gray to almost black, and the back or sides may have stripes or other markings. They are 1½ to 2 inches long when fully grown. The species of greatest importance as sugarbeet pests in the North Central States are the black cutworm, glassy cutworm, spotted cutworm (fig. 33), and the variegated cutworm. The glassy cutworm is definitely a subterranean feeder, while the others feed primarily at or near the soil surface. Control measures should be modified in accordance with these differences in feeding habits between the various species.



TC–3668

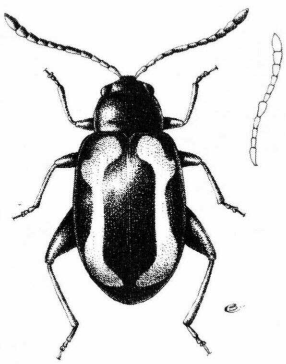
FIGURE 33.—The spotted cutworm. Nearly twice natural size.

Control.—For the control of leaf-feeding cutworms, trichlorfon may be applied to the foliage as for armyworms.

Flea Beetles

Adult flea beetles (fig. 34) are small, shiny, dark brown or black insects, ranging from about 1/16 to almost 1/4 inch in length. Some species have light-colored stripes or bands on their backs, and, as the name indicates, they jump like fleas when approached or disturbed. The feeding damage of the adults consists of very small holes chewed in the beet leaves, and large numbers

cause severe damage to the beets in the seedling stage and sometimes destroy a stand in 3 or 4 days. The species that most commonly infest sugarbeets in the North Central area of the United States are the hop flea beetle, potato flea beetle, and spinach flea beetle.



TC–2754

FIGURE 34.—The striped flea beetle. About 15 times natural size.

Control.—Apply parathion to the foliage at 0.5 pound per acre in a dust or spray as soon as the first signs of feeding are noticed.

Garden Symphylan

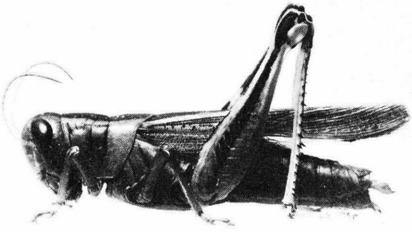
The garden symphylan is a very small, active, whitish, centipedelike creature that lives in the soil. The adults have chewing mouthparts and are about ¼ inch long. They move through cracks and holes in the soil and feed on the roots of various plants, including sugarbeets. They are difficult to control, because usually over 50 percent of the population is below the top 6 inches of the soil.

Control.—Parathion is partially effective in the control of the garden symphylan. It should be applied as a preplanting treatment to the soil surface in a spray or granular formulation at 5 pounds of toxicant per acre and thoroughly worked into the upper 6 inches. After parathion is applied at this dosage all animals should be kept off the treated area for 48 hours.

Grasshoppers

If climatic and environmental conditions are such as to favor the production of a large spring brood of grasshoppers, they may do a great deal of damage to sugarbeets. The species most likely to do damage are the two-striped grasshopper (fig. 35), the differential, and the lesser migratory grasshopper. They eat the leaves and crowns of young plants, and if present in sufficient numbers, may prevent the growth of new foliage and cause the death of the plants.

Control.—Carbaryl may be used as a spray on sugarbeet foliage for grasshopper control at the rate of 0.5 to 1.0 pound per acre, or malathion may be used at 1 to 2 pounds per acre.



C & F–215

FIGURE 35.—Adult of the two-striped grasshopper. Twice natural size.

Lygus Bugs

Lygus bugs are sucking insects that frequently infest sugarbeets. There are several species, all of which are very similar in appearance. The body is flattish, about 3/16 of an inch long, and half that wide. The color varies from pale green to dark brown. They ordinarily overwinter in the adult stage

and lay eggs in young, green plants (either weed hosts or cultivated plants) in the spring. There are several generations a year. Adults are very likely to move into beet fields from adjacent or nearby alfalfa fields, especially after a cutting of hay. Their feeding seems to have a toxic effect and causes large cavities and distorted growth wherever there are feeding punctures.

Control.—Parathion applied to the foliage as a dust or spray at 0.5 pound per acre is effective against those lygus bugs present at the time of application, but repeated applications may be necessary to control successive infestations. Naled applied as a spray at 1 pound in 35 gallons of spray per acre has given very good results in controlling this insect on sugarbeets. Control is difficult since lygus bugs rarely remain long in a sugarbeet field.

Spider Mites

While spider mites are not true insects, they are considered in this category. These tiny, spiderlike creatures frequently overwinter in trash, on weeds, or in alfalfa fields. They have a short life history, and there are a number of generations each year. Infestations usually begin along an edge of a field and spread inward. Mites infest the foliage, usually the lower sides of the leaves, which eventually turn brown and die.

Control.—Carbophenothion applied to the foliage at 0.5 pound per acre as a spray, or 1 pound as a dust, is effective against mites on sugarbeets. Dusting sulfur is also effective in areas of relatively low humidity and high temperature.

Spinach Leaf Miner

The spinach leaf miner is commonly found infesting sugarbeets. The adult flies lay their eggs on the surface of the beet leaves in the spring when the beets are young. When the eggs hatch, the small white or yellowish maggots bore into the leaf tissue and make feeding tunnels or mines between the upper and lower surfaces of the leaves. These tunnels or mines form large, irregular-shaped whitish blotches in the leaves, and heavily infested leaves soon turn brown and die. Severe loss of foliage retards growth of the plant and results in reduced yield, but ordinarily, losses resulting from this insect's attack are not severe.

Control.—Plants may be dusted or sprayed with parathion at 0.5 pound per acre when the insects first appear, with good results. Trichlorfon at 1.5 pounds per acre in spray is effective also.

Sugarbeet Root Maggot

The sugarbeet root maggot is the larva of a shiny black fly about ¼ inch long. The eggs are laid about one-fourth inch under the soil surface around beets. When the maggots hatch, they feed by rasping the beet roots and often cut off the taproots and feeder roots. Severe infestations may occasion the death of 80 to 90 percent of the young sugarbeet plants in a field.

Control.—Dieldrin has proved very effective against this insect when used as a seed treatment, mixed dry with the seed at the rate of 0.5 pound of 75-percent dieldrin wettable powder per 100 pounds of seed.

Webworms

Young larvae of the beet and garden webworms eat small patches from the underside of sugarbeet leaves. As the worms grow larger, their appetites increase correspondingly, and a severe infestation may destroy practically all the foliage in a beet field and, subsequently, feed on the stems and crowns of the plants. Webworms have a relatively short life history, and, consequently, a heavy infestation may

develop and cause severe injury before growers are aware the insects are present. The small, slender, tan- and yellow-marked moths lay their eggs on the undersides of the beet leaves or on leaves of some suitable weed host plants that may be growing in the field or nearby. Lambsquarter, the related atriplexes, and Russian-thistle are all recognized as good host plants of the beet webworm. The eggs, which are generally white or yellowish, are very small and usually found in groups or clusters. The larvae are usually tan or pale to dark green, about 1 inch long when full grown, with a black stripe and several black spots on the back (fig. 36).

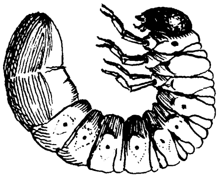
TC–7116

FIGURE 36.—The beet webworm. Twice natural size.

Control.—Destruction of all weed hosts in or near a sugarbeet field is very helpful. Parathion at 0.5 pound per acre may be used effectively as a foliar dust or spray against this insect. Trichlorfon as a foliar spray at 1.5 pounds of toxicant per acre also may be used. Phosphamidon applied at 1 pound per acre in 35 gallons of spray per acre has proved effective too.

White Grubs

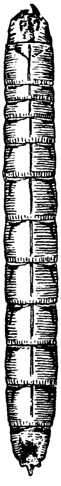
Sometimes the roots of sugarbeets are damaged by large, whitish, brown-headed grubs, which live under the soil surface and which are the larvae of several species of scarab beetles. Full-grown white grubs (fig. 37), usually found curled up in the soil, are 2 or more inches long when extended. These grubs never appear above the soil surface but feed underground on the roots of small beet plants and also eat large holes in the sides of the beets. Severe feeding injury, especially if the beets are small, may cause death of the plants.



C & F–2526

FIGURE 37.—White grub. About natural size.

Control.—The adult beetles prefer to lay their eggs in grass and pastureland, and since this is a good environment for the grub's development, it is wise to avoid planting sugarbeets in soil the first season after sod or pasture.



TC–7144

FIGURE 38.—One of the corn wireworms. Twice natural size.

Wireworms

Wireworms are white to yellowish jointed worms, which are the larvae of the so-called "click" or "snapping" beetles. Several kinds, including the eastern field wireworm and the corn wireworm (fig. 38), may damage or destroy small sugarbeet plants. They feed on the taproots just below the soil surface and often cut them off, causing the death of plants. The species that damage sugarbeets in this area favor grasslands and pastures for egg deposition, and usually the heaviest wireworm infestations are found in such areas.

Control.—Grow intertilled crops the first season after plowing out wireworm-infested grass or pasture-lands.

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- Keep children away from machinery.
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